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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G06K 11/18, 9/22

A1

(11) International Publication Number: WO 99/26191

(43) International Publication Date: 27 May 1999 (27.05.99)

(21) International Application Number: PCT/IB98/01957

(22) International Filing Date: 13 November 1998 (13.11.98)

(30) Priority Data:
60/065,866 14 November 1997 (14.11.97) US
09/190,652 12 November 1998 (12.11.98) US

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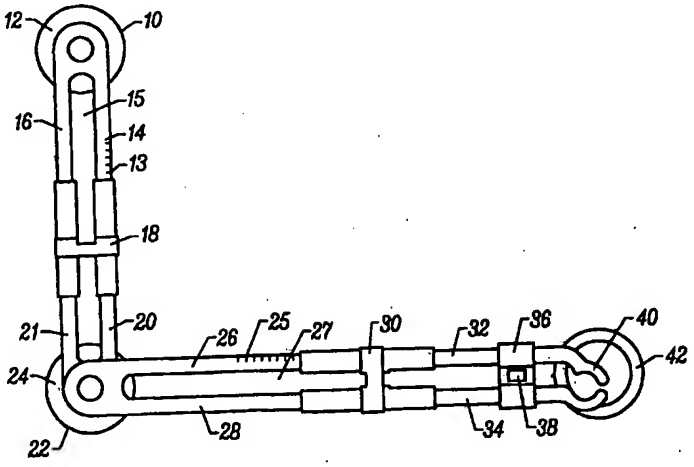
(81) Designated States: JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DRAWING RENDERING DEVICE



(57) Abstract

An apparatus and method are provided which measure, in real time, the movements of an implement (46) attached to one end of the apparatus. A user holding the implement (46) in his or her hand makes natural writing or drawing motions with the implement (46). The position of the implement (46) is converted in real time into representative signals as the user moves it in three-dimensional space or over a writing surface. In one embodiment a first arm (15) is pivotally connected to a surface and to a second arm (27). A first angle sensing mechanism (10) is coupled to the first arm (15) and generates a first signal representative of the angular position of the first arm (15) relative to one or more directions in space which may be but are not limited to directions along the surface. A second angle sensing mechanism (22) is coupled to the second arm (27) and generates a second signal representative of the angular position of the second arm (27) with respect to the first arm (15). A holder (42) for an implement (46) is attached to the end of the second arm (27) opposite the end to which the first arm (15) is attached.

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DRAWING RENDERING DEVICE

FIELD OF THE INVENTION

The present invention relates to an apparatus and method that provides electronic signals that correspond to handwriting and drawings and more particularly to electro-mechanical devices that translate, in real time, handwriting and drawing movements to electronic signals.

BACKGROUND

For many people, handwriting and freehand drawing is one of the most natural and comfortable ways to interface with electronic devices. A key to electronically capturing handwriting lies in the determination of human hand movements relative to some origin point. Determination of distances relative to the origin point can be achieved by measuring distances using a variety of means. Prior technologies that capture handwriting and/or drawings to store them on magnetic media or present them on electronic screens used electromagnetic, resistive or similar types of graphic tablets for this purpose. Mainly, prior art methods can be divided into those that rely on a digitizing tablet, and those that do not. Examples of systems that rely on digitizing tablets include: John Hollerbach of MIT, "An Oscillation Theory of Handwriting" (Biological Cybernetics, vol. 39, pp 139-156, 1981) describes a mechanical apparatus that measures acceleration during handwriting and integrates the measured acceleration to obtain velocity. A digitizing tablet was employed to measure position. Hollerbach's apparatus was geared towards measuring

acceleration during writing cursive script words. His apparatus did not address handwriting capture and lacked portability. Others have developed systems generally suited to the real time digitization of handwriting, but typically each required the provision of a digitizing tablet. Such tablets may make these devices much less portable or attractive for common everyday use.

Digitizing systems not coupled to writing implements are also known in prior art. Bauman et al., U.S. Patent 4,331,954, which is hereby fully incorporated by reference, describes a two-dimensional digitizer capable of finding position coordinates of images, pictures and graphical data. However, Bauman's apparatus is not a writing mechanism and lacks a writing implement holder. Purcell, U.S. Patent 5,065,145, which is hereby fully incorporated by reference, describes a two-dimensional digitizer and a method for producing signals corresponding to the position of cursor coordinates of cross-hairs. Each of these prior art digitizers are mainly directed towards the digitizing of pre-existing objects and designs and not towards recording the movements of a writing implement in real time.

An example of a system that does not rely on a digitizing tablet includes Epperson, U.S. Patent 5,247,137. Epperson relies on an accelerometer-based inertial navigation system to track the writing implement. Since the position of the writing implement in Epperson is determined by double integration of the measured accelerations, this system is subject to potentially large error and drift.

Thus there is a need for a two-dimensional and three-dimensional apparatus and method for providing electronic signals that correspond to handwriting and drawings in real time while providing a comfortable writing and freehand drawing environment.

SUMMARY OF THE INVENTION

One embodiment of the present invention is a light weight electro-mechanical apparatus which measures, in real time, the movements of an implement attached to one end of the apparatus. A person holding the implement in his or her hand makes natural writing or drawing motions with the

implement. The position of the implement is converted in real time into representative signals as the user moves it in three-dimensional space or over a writing surface.

In one aspect of this embodiment a first arm is pivotally connected to a surface and to a second arm. A first angle sensing mechanism is coupled to the first arm and generates a first signal representative of the angular position of the first arm relative to one or more directions in space which may be but are not limited to directions along the surface. A second angle sensing mechanism is coupled to the second arm and generates a second signal representative of the angular position of the second arm with respect to the first arm. A holder for an implement is attached to the end of the second arm opposite the end to which the first arm is attached.

In another aspect of this embodiment, the first angle sensor and the second angle sensor both measure angular positions of the first and second arms in a plane substantially parallel to the surface in order to be able to detect handwriting motions of the implement on the surface. In one aspect of this embodiment a sensor measures when the implement is in contact with the surface. In another aspect of this embodiment a sensor measures the pressure applied by the tip to the surface.

In another embodiment of the invention, the first angle sensor, the second angle sensor, both angle sensors, or a third angle sensor are used to track the motions of the implement in three-dimensional space.

The output of the angle sensors uniquely determines the position of an implement placed in the holder for known lengths of the first arm and second arm. In one aspect of the invention the length of one or both of the arms is adjustable by the user. The adjustment of arm length can be accounted for by the system in a number of ways including allowing the arm length to vary as the user moves the implement, while one or more sensors in the arms output one or more signals related to the lengths of the arms. Additionally the arm length could be adjustable in fixed increments by the user.

In another aspect of the invention the signals are converted into electrical signals which can be stored in a computer memory or any other suitable storage device such as a hard disk, a floppy disk or a tape and displayed on a computer display device. Additionally, the signals can be transmitted via wires, fiber optics, radio or microwaves to another location. In one embodiment of the invention the signals are modulated on a carrier and transmitted over the telephone system to another location.

Another embodiment of the present invention is a system and method for simultaneously writing on a physical surface and having the writing display on an electronic display unit. This embodiment of the invention includes: (i) a holder for a writing implement, (ii) a mechanism, mechanically coupled to the holder and adapted to be mechanically secured to the writing surface, for sensing a lateral position of the implement relative to a reference location, and (iii) a mechanism for providing electronic signals, representative of the position of the implement. The writing implement is inserted into the holder and a user can then write on the surface, using the writing implement while a trace corresponding to the electrical signals is displayed on the electronic display.

Yet another embodiment of the present invention is a two-dimensional or three-dimensional mechanical apparatus that is specifically designed for handwriting and freehand drawing. It includes a holder for a writing implement. A pressure sensor senses when the writing implement is up or down. Preferably, a code reader, such as a bar-code reader in the holder, detects a code on the writing implement which contains information about the characteristics of the writing implement. As the user writes marks on a surface, such as ordinary handwriting, the apparatus transmits the position information obtained by the angle sensors and the pressure sensor through a serial or game port to an electronic device, such as a personal computer. This information can then be presented in real time on an electronic screen. The information obtained by the sensors can be transferred over telephone lines to other electronic devices for display or processing.

The present invention eliminates the previous need for space consuming and costly graphic tablets. The present apparatus is based on a mechanical approach which is inexpensive and reliable. The apparatus is easy to use; a user need only to insert an implement in the holder and begin writing or drawing. In one embodiment of the invention the signals output from the apparatus are input to a serial or game port of an electronic device. The electronic device can include but is not limited to a processor which can be any type of processor including a microprocessor, dedicated logic, a digital signal processor, a programmable gate array, a neural network, or a central processor unit implemented in any other technology, or a computer, a computer system, a mainframe system, or any other type of general or special purpose computing system which includes an interface, a processor, and a memory. Additionally, the signals can be input into a modulator for transmission over a communication channel. The communication channel can include but is not limited to radio, microwaves, telephone, or a power distribution channel.

BRIEF DESCRIPTION OF THE FIGURES

Figures 1 and 2 are schematic drawings depicting, respectively, a top view and side view of an embodiment of the invention which can be used to generate signals representing the position or motion of the arms.

Figure 3 depicts an embodiment of the invention showing various implements, each with a different bar-code.

Figure 4 depicts an embodiment of the invention in which the implement includes a scanner.

Figure 5 is a block diagram of an embodiment of hardware used to feed angular position signals to a personal computer.

Figure 6 depicts an embodiment of the invention coupled to a telephone for transmitting and/or receiving information via telephonic communication channels.

Figure 7 depicts an embodiment of the invention which contains actuating mechanisms to move the arms of the device so that the device can be used to output and/or input information.

Figure 8 is a diagram depicting the use of a game port type connector to transmit and/or receive electrical signals from an embodiment of the invention.

Figure 9 depicts a lateral view and a bottom view of another embodiment of the invention which incorporates optical angular sensors.

Figures 10(a) and 10(b) depict two embodiments of optical angle sensors.

Figure 11 depicts a flow chart for software that can be used in conjunction with an embodiment of the rendering device to allow input of text or graphical objects into a computer.

DETAILED DESCRIPTION

The present invention is a handwriting and drawing apparatus which can provide real time electronic signals that correspond to drawings of any type. Specifically, the present invention can be used to translate human handwriting and drawings to electronic signals that can be saved on electronic magnetic media and/or displayed in real time on electronic display screens.

Figures 1-2 illustrate an embodiment of the present invention. Figure 1 depicts drawing rendering device 1. First arm 15 is pivotally attached to joint 12. As depicted in Figure 2, joint 12 is attached to clamp 44. Clamp 44 is used to reversibly attach the apparatus to a physical drawing surface, for example a notebook. The apparatus of Figures 1 and 2 can be used in conjunction with virtually any planar surface. Clamp 44 can be any type of clamping device or other device to keep the end of first arm 15 stationary including but not limited to any type of friction based device, magnetic device, suction device, or simply a weight.

Joint 12 enables first arm 15 to rotate in a two-dimensional plane, parallel to the drawing surface plane. This rotation is relative to fixed clamp 44. As shown in Figure 1, angular sensor 10 detects the rotation of first arm 15

relative to joint 12. This rotation is translated into electrical digital or analog signals that are fed to an electronic device, as described below. In an alternate embodiment of the invention not depicted in Figure 2, joint 12 allows rotation of first arm 15 out of the plane of the drawing surface to allow movement of first arm 15 in three dimensions.

First arm 15 consists of two male type telescopic rods 14 and 16, inserted in two female type telescopic rods 20 and 21. The rods are connected with telescopic clamp 18. Telescopic clamp 18 enables length variation of first arm 15, making first arm 15 a telescopic mechanism. Distance scale 13 on rod 14 shows the length of arm 15. The user can input first arm 15 length information to an electronic device such as a personal computer via the keyboard of the personal computer. Other techniques can be used to measure and input first arm 15 length including but not limited to electro-mechanical or opto-mechanical sensors coupled to first arm 15 and connected to a computer.

Joint 24, at the end of first arm 15 opposite joint 12, connects first arm 15 to a second arm 27. Second arm 27 consists of two male type telescopic rods 26 and 28, and two female type rods 32 and 34. Telescopic clamp 30 enables length variation to second arm 27, thus making second arm 27 a telescopic mechanism. Distance scale 25 on rod 26 shows the length of arm 27. The user can input arm 27 length information to an electronic device such as a personal computer via the keyboard of the personal computer, or as discussed above in connection to first arm 15 an automated arm length sensor can be used to directly input the arm length or arm length variation into a computer.

At the end of second arm 27 is a ring 40 that is adapted to receive an implement holder 42. Implement holder 42 can be used to hold any type of implement 46, including but not limited to a writing implement, a light pen or wand, or a scanner. Near ring 40, a plate 36 spans female rods 32 and 34. Proximity sensor 43 is attached to plate 36 facing the drawing surface. Proximity sensor 43 detects the touching and de-touching of implement 46 to a drawing surface and translates it to digital or analog electronic signals. The signals are sent to an electronic device as described below. Switches suitable

for proximity sensor 43 include but are not limited to a micro switch or a pressure sensor.

As shown in Figure 1, second arm 27 pivots on joint 24, relative to first arm 15, in a plane substantially parallel to the drawing surface. The relative angular rotation of first arm 15 with respect to second arm 27 is detected by angular position sensor 22. Angular position sensor 22 translates the detected angle into digital or analog electronic signals. These electronic signals are fed to an electronic device, as described below.

Ring 40 at the end of second arm 27, opposite joint 24, is adapted to receive implement holder 42. Preferably, holder 42 is in the form of a truncated cone and is made of semi-rigid material such as rubber. Implement holder 42 is adapted to receive implement 46 as shown in Figure 2.

Optionally, bar-code label 48 is attached to implement 46. This bar-code label may encode certain information about implement 46 including but not limited to make, color, thickness, shadow, tip size, life span, ink maximal volume or type of implement including pen, pencil, marker, or paintbrush. A bar-code reader 38 is attached on the top side of plate 36, opposite the drawing surface. Bar-code reader 38 is positioned to read bar-code label 48 on implement 46 and translates bar-code label 48 to electronic signals. Bar-code reader 38 can be configured such that bar-code label 48 is read by bar-code reader 38 as implement 46 is inserted into holder 42 and rotated. The electronic signals are fed to an electronic device, and can be displayed on an electronic screen in real time, either as such or as a modification of the trace displayed on the screen. For example, if the bar-code encodes color, the trace can be given the corresponding color.

In another embodiment of the invention, the signals generated by drawing rendering device 1 (e.g., by sensors 10, 22, 43, and/or 38) are then used to generate position information. The position information, for example x-y coordinates of the implement can be calculated using a processor, a computer or micro-controller 72. Once the position information is calculated, the appropriate display characteristics as determined, for example, by bar-code label

48 are displayed. The information can be displayed in real time on a display screen. Characteristics of implement 46, such as color and/or thickness provided by bar-code label 48, can be expressed on the display by characteristics of the trace on the display. In yet another embodiment, the signals generated by drawing rendering device 1 are input into a computer and used to provide annotations for documents, web sites, or other files in the computer.

Figure 3 depicts an embodiment of the invention showing various implements, each with a different bar-code. As depicted in Figure 3, the bar-code and the reader can be used to provide information concerning implement type (e.g., brush 302, pen scanner 304, marker 306, etc.), owner 308, or tip thickness.

Figure 4 depicts an embodiment of rendering device 400 in which the implement is scanner 402. Any scanner can be used, but in the embodiment shown in Figure 4 scanner 402 contains radiation source 404 and detector 406. Radiation from the source is absorbed or reflected by the image on the surface. In this embodiment, information from detector 406 can be combined with position information generated from rendering device 400 allowing drawings or images to be scanned in a bit mapped format as detected by detector 406. This embodiment can be used, for example, to enter bit mapped images into a document which is stored in a computer. The relative position of scanner 402 is determined by the angle sensors of the rending device and the bit mapped image is generated from the output from scanner 402.

Referring again to Figures 1 and 2, angular position sensor 10, proximity sensor 43, angular position sensor 22 and bar-code reader 38 generate signals that relate to their activity. Sensors 10 and 22 can be potentiometers or optically based. For example potentiometers commercially available from BI Technologies Corporation, 4200 Bonita Place, Fullerton Ca 92635-1053 can be used. Sensors 10, 22, 43 and bar-code reader 38 may be operated by electric voltages supplied from batteries or an external power source. The power supply input and the electronic signals output may be done by means of electric wiring (not shown) hidden inside the telescopic bars of first and second arms.

Additionally, the output of any or all of the sensors can be sent out via fiber optic cable or radio waves.

Handwriting and freehand drawing consists of a series of hand strokes. Typically, each stroke starts in a reaching movement in which the writer brings the implement to the desired starting point. Implement 46 normally rests near the starting point in an up position, in which it does not touch the surface. If proximity sensor 43 is a micro switch then touch-down of tip 50 on a surface is detected by the micro switch. Lateral pen travel is detected by angular position sensors 10 and 22. Alternatively, proximity sensor 43 can be a pressure sensor. In that case, the pressure of tip 50 on a surface is detected by sensor 43 which may be without limitation a switch, a micro-switch, or a pressure sensor. The pressure signals generated are sent to an electronic device such as a personal computer and the thickness of trace generated on the electronic screen can be controlled to correspond to the pressure of tip 50 on the surface.

One phenomenon associated with handwriting is that the reaching movements and the pen-down movements typically follow acceleration patterns. The movement of implement 46 starts at zero velocity, reaches peak velocity and then decelerates to full stop. A second associated phenomenon is that typically the speed slows down when drawing a curve. A third associated phenomenon is that typically, when characters are written, the tangential velocity pattern of the relative timing peaks is maintained steadily, even if, usually, character shapes differ from one character to the other. The present invention makes it possible to calculate and store these handwriting dynamics with minimal interference to natural hand movement.

Figure 5 is a high level schematic circuit diagram of an embodiment of hardware used to feed analog angular position signals obtained from sensors 10 and 22 and sensor 43 to a personal computer serial port 68. In one embodiment of the invention, proximity surface sensor 43, angular position sensor 10 and angular position sensor 22 produce analog electrical signals. These signals are fed to a micro-controller 72. Micro-controller 72 consists of multiplexer 60, analog-to-digital converter 62 and processor 64. Processor 64 produces digital

signals representative of the analog signals produced by sensors 10 and 22 and the signal produced by switch 43 as to whether it is open or closed. The digital data output from micro-controller 72 goes through an RS232 line driver 66 that feeds the digital data by way of transmit data command (TXD) 67 into a serial port 68. Power supply 70 gets service voltage Vcc 76 by using two RS232 commands: data terminal reader (DTR) 72 and request to send (RTS) 74. Service voltage Vcc 76 can be used to operate sensors 10 and 22 and sensor 43 on the apparatus.

Handwriting data obtained from the sensors can be stored by a personal computer on magnetic media and can be presented on a display screen. This handwriting data can be sent over telephone lines to other electronic devices such as other personal computers. Handwriting signals can be transmitted over dedicated telephone lines such as point-to-point lines, non-dedicated telephone lines such as dial-up lines, encrypted telephone lines, ISDN heavy duty telephone lines, and via Internet and Internet-like global webs.

Figure 6 depicts an embodiment of the invention in which rendering device 600 is attached to a phone. A standard phone is depicted in Figure 6, but a cordless phone or a cellular phone could also be used. In this embodiment of the invention, the signals output from rendering device 600 are modulated on carrier waves within the transmission bandwidth of the telephone system and transmitted over phone lines. The signal can be either electrical and combined with the signal from the mouth piece of the phone, or the signal can be converted to an acoustic signal and acoustically coupled into the phone through the mouth piece. The electronic signal can be combined with the voice signal through a suitable modular jack which can be plugged into the phone. Acoustic coupling allows the rendering device to be easily attached to any existing phone system without requiring any modifications.

The signals generated by the rendering device are capable of being transmitted by standard telephones and can thus be transmitted in analog format just as ordinary voice data is so that special protocols are not required. Additionally, since the signals are within the frequency range transmitted and

received by telephones, the signals can be stored on and retrieved from standard voice storage devices such as answering machines, voice mail systems, or tape recorders.

The modulated signals received over the telephone or recovered from an answering machine or tape can be input into a demodulator to recover the signals generated by rendering device 600. The recovered signals can then be used in any way desired as discussed above and below. For example, the signals can be input into a computer and displayed on a display device.

Figure 7 depicts an embodiment of the invention which contains actuating mechanisms to move the arms of the device. In this embodiment rendering device 700 further includes first actuating mechanism 702 which rotates first arm 704 about pivot point 706 of clamp 708 in response to a first input signal. Second actuating mechanism 710 rotates second arm 712 about pivot point 714 of first arm 704 in response to a second input signal. Third actuating mechanism 716 is placed near the end of second arm 712 to raise or lower implement tip 718 in response to a third signal. It is noted that the first, second, and third input signals need not be separate electrical signals but can be combined into one electrical signal using, for example, well known modulation or multiplexing techniques.

In another embodiment, rendering device 700 additionally contains angle sensing devices and a micro-switch similar to those described in Figures 1 and 2. This allows rendering device 700 to both output signals and generate images using the first, second and third input signals. This embodiment can be used in combination with a phone as shown in Figure 6 to allow two way communication of rendering device signals over the phone system.

Figure 8 is a high level schematic circuit diagram of the hardware used to feed electrical signals obtained from sensors 10 and 22 and sensor 43 of Figures 1 and 2 into a computer game port. Male plug 80 contains 5 pins. Pin 1 is a 5 volts pin. Pin 3 is the joystick #1 X axis pin. Pin 3 gets its input from angular position sensor 10 of first arm 15. Pin 6 is the joystick #1 Y axis pin. Pin 6 gets its input from angular position sensor 22 of second arm 27. Pin 2 is

the joystick #1 fire 1 pin. Pin 2 gets its input signal from sensor 43 on second arm 27. Pin 4 is the ground pin for proximity surface sensor 43. Male plug 80 is inserted into a PC game port.

Figure 9 depicts a lateral view and a bottom view of another embodiment of the invention. In this embodiment clamp 102 is connected by rotatable joint 104 to first arm 106. First arm 106 is rotatably connected by rotatable joint 108 to second arm 110. At the end of second arm 110 opposite joint 108 is implement holder 112. Implement holder 112 is on the end of cantilevered section 114 of second arm 110. Cantilevered section 114 pivots vertically about pivot point 116 and switch end 118 of cantilevered section 114 placed just below micro-switch 120 such that when tip 122 of an implement placed in implement holder 112 is pressed down in contact with the surface, micro-switch 120 will be contacted by switch end 118. When tip 122 is lifted off of the surface micro-switch 120 will cease to be contacted. Thus micro-switch 120 detects when tip 122 of an implement placed in implement holder 112 is in contact with the surface.

Clamp 102 contains first optical angle sensing mechanism 124 for sensing the angular position of first arm 106 with respect to clamp 102. Housing 126 contains second optical angle sensor 128 for sensing the angular position of first arm 106 with respect to second arm 110. Clamp 102 also contains circuit board 130. In one embodiment of the invention, circuit board 130 converts the signals from the sensors into the appropriate protocols for input into an external device. For example, circuit board 130 could convert the signals from the two angle sensors into a format suitable to be input into a computer through a standard mouse input port or a joystick input port. Circuit board 130 need not reside in clamp 102. It can be in the implement, external to the rendering device, or its functions could be implemented in software on a computer.

In another embodiment circuit board 130 converts the signals into position information which is displayed on digital displays on the rendering device. The digital displays, not shown in Figure 9, allow a user to precisely

measure or draw certain figures or characters as desired. This feature is useful for draftspersons or architects.

Figure 10(a) shows a detailed view of an optical angle sensor 200 in accordance with an embodiment of the present invention. In this embodiment the sensor contains rotatable barrel 202 with tapered transmission strip 204 partially coiled around it. Tapered transmission strip 204 extends from rotatable barrel 202 between source 206 and detector 208. Optical angle sensor 200 measures the relative angle between two components as follows. The two components are rotatably coupled to rotatable barrel 202 such that when the first component rotates, rotatable barrel 202 rotates about pivot point 210 and tapered transmission strip 204 either coils up or uncoils from rotatable barrel 202 and passes between source 206 and detector 208. Tapered transmission strip 204 is constructed such that the transmission of radiation from source 206 through tapered transmission strip 204 to detector 208 decreases in one direction along tapered transmission strip 204. As depicted in Figure 10(a) tapered transmission strip 204 becomes less transmissive in the direction away from barrel 202. As tapered transmission strip 204 either coils or uncoils from rotatable barrel 202 the amount of radiation from source 206 detected by detector 208 varies in relation to the angle between the two components.

Tapered transmission strip 204 can be made of any material which can be manufactured with a varying or tapered transmission. Examples of suitable materials include but are not limited to film, a strip with holes in it in which the ratio of open area of the holes to area of the strip varies in a direction along the strip allows a varying amount of radiation to pass through. The transmission of tapered transmission strip 204 can be designed to provide any function of transmission of radiation from source 206 to detector 208 that is desired. For example, the transmission of tapered transmission strip 204 could vary sinusoidally or cosinusoidally in order to have the signal detected by detector 208 be the sine or cosine of the angle between the two components.

In another embodiment not shown in Figure 10(a), the strip has a reflectivity which varies along a direction and source 206 and detector 208 are

placed on the same side of the strip. In this embodiment, the radiation reflected from the strip is related to the relative angle between the two components. In yet another embodiment of the optical angle sensor not depicted in (a), strip end 212 is held fixed and the strip is held under tension by rotatable barrel 202. Then, as rotatable barrel 202 rotates, the strip is stretched more or less and then made slightly thinner or thicker which transmits more or less radiation from source 206 to detector 208.

Figure 10(b) depicts yet another embodiment of an optical angle sensor. In this embodiment two components are rotatably coupled at pin 218. Varying transmission disc 220 is coupled to pin 218 and varying transmission disc 220 passes between source 222 and detector 224. Varying transmission disc 220 allows radiation to pass from source 222 to detector 224 as a function of the angle about varying transmission disc 220. As the angle between the two components is varied, pin 218, which is rigidly connected to one of the components, rotates relative to the other component. This rotation causes varying transmission disc 220 to rotate between source 222 and detector 224 causing more or less radiation to be transmitted from source 222 to detector 224. The amount of radiation passed by varying transmission disc 220 can be made to be any desired function of angle about varying transmission disc 220. It could vary sinusoidally, cosinusoidally, linearly, logarithmically, or in any other way desired. In another embodiment not depicted, the varying transmission disc has a variable reflectivity and the source and detector are placed on the same side of the varying transmission

Figure 11 depicts a flow chart for software that can be used in conjunction with an embodiment of the rendering device to allow input of text or graphical objects into a computer. A rendering device is connected to a computer and the signals from the rendering device are input into the computer memory. The software functions as follows. In step 1102 the updated position information from the rendering device is determined. In step 1104 it is determined if the updated position information from the rendering device shows that the user has manipulated the implement to generate a special symbol which

is to be recognized by the object recognition software. If a special symbol has not been generated then at step 1106 the position of the implement is updated on a display attached to the computer. The display displays the motions of the implement as the user manipulates it to write or draw. The program then goes from step 1106 to step 1102.

At step 1104 if a special symbol is recognized then the program goes to step 1108. Special symbols to be recognized may include but are not limited to words like "circle," "radius=30mm," "center=this position," or "square." At step 1108 the symbol is sent to a recognizer to try to identify it. Next is step 1110 in which the program goes into recognition mode in order to try to identify the symbol. In step 1112 it is determined if the symbol is recognized. If it is not recognized then step 1106 is next. If it is recognized then the object represented by the symbol is displayed or the user is given a menu to select the object for display. When a recognized object is displayed, it is treated not as a bit mapped image but as a graphical object. After step 1114, step 1116 is executed and the recognized symbol is removed from the display. This allows the recognized symbol to be replaced on the display by the object it represents. After step 1116 step 1102 is executed.

The foregoing description of embodiments of the present invention are presented for the purposes of illustration and description only. They are not intended to be exhaustive or to limit the invention to the forms disclosed. Many modifications and variations will be apparent to practitioners skilled in the art. It is intended that the scope of the invention be defined by the following claims and their equivalents.

WHAT IS CLAIMED IS:

1. A rendering device, comprising:

a first arm with a first end and second end, the first end of the first arm adapted to be pivotally connected to a surface;

a first angle sensing mechanism coupled to the first arm for sensing an angular position of the first arm relative to a direction on the surface, wherein the first angle sensing mechanism generates a first signal representative of the angular position of the first arm relative to the direction on the surface;

a second arm with a first end and a second end, the first end of the second arm pivotally connected to the second end of the first arm;

a second angle sensing mechanism for sensing an angular position of the second arm relative to the first arm, wherein the second angle sensing mechanism generates a second signal representative of the angular position of the first arm relative to the second arm; and

a holder for an implement coupled to the second end of the second arm.

2. The device of claim 1, wherein:

at least one of the first angle sensing mechanism and the second angle sensing mechanism includes a potentiometer.

3. The device of claim 1, wherein:

at least one of the first angle sensing mechanism and the second angle sensing mechanism includes an optical angular sensing mechanism.

4. The device of claim 1, wherein:

at least one of the first angle sensing mechanism and the second angle sensing mechanism senses the angle between the second arm and the surface.

5. The device of claim 1, wherein:

at least one of the first arm and the second arm has an adjustable length.

6. The device of claim 5, wherein:

the at least one arm having an adjustable length includes a length scale for measuring the length of the arm.

7. The device of claim 5, wherein:

the at least one of the first arm and the second arm includes a sensor which outputs a signal related to the length of the arm.

8. The device of claim 1, comprising:

an elevation sensor coupled to the second arm for sensing the elevation of the holder relative to the surface.

9. The device of claim 8, wherein:

the elevation sensor includes a pressure sensitive switch.

10. The device of claim 9, wherein:

the implement is a writing implement.

11. The device of claim 10, wherein:

the pressure sensitive switch measures a pressure related to the pressure applied by the writing implement to the surface.

12. The device of claim 1, comprising:

a reader for reading a code on the implement, wherein the implement is a writing implement.

13. The device of claim 12, wherein:

the code is related to a color of the writing implement.

14. The device of claim 12, wherein:

the code is related to a tip thickness of the writing implement.

15. The device of claim 12, wherein:

the code is related to the type of the writing implement.

16. The device of claim 1, wherein:

the first signal and the second signal are capable of being transmitted over telephone lines.

17. The device of claim 16, wherein:

the first signal and the second signal are modulated on carrier frequencies between about 300 Hz and about 3.6 kHz.

18. The device of claim 16, wherein:

the first signal and the second signal are modulated on a carrier frequency between about 500 Hz and about 2 kHz.

19. The device of claim 16, wherein:

the first signal and the second signal are modulated on a carrier frequency between about 1.5 kHz and about 2 kHz.

20. The device of claim 1, comprising:

a processor, wherein the first signal and the second signal are input into the processor.

21. The device of claim 20, comprising:

a display, the display being coupled to the processor, wherein the first signal and the second signal are input into the processor and processed for display on the display.

22. A rendering system, comprising:

a first arm with a first end and second end, the first end of the first arm adapted to be pivotally connected to a surface;

a first actuating mechanism coupled to the first arm for rotating the first arm relative to a direction on the surface, wherein the first actuating mechanism rotates the first arm in response to a first electrical signal;

a second arm with a first end and a second end, the first end of the second arm pivotally connected to the second end of the first arm;

a second actuating mechanism coupled to the second arm for rotating the second arm relative to the first arm, wherein the second actuating mechanism is responsive to a second electrical signal; and

a holder for an implement coupled to the second end of the second arm.

23. The device of claim 22, comprising:

a device for receiving signals from a telephonic communications system, the device for receiving signals being coupled to the first and second actuating mechanisms.

24. The device of claim 22, wherein:

at least one of the first arm and the second arm has an adjustable length, and includes a actuator for changing the length of the arm in response to a third electrical signal.

25. The device of claim 22, comprising:

an implement elevation actuator which elevates the tip of the implement from the surface in response to an elevation activation electrical signal.

26. The device of claim 22, wherein:

the implement is a writing implement.

27. The device of claim 22, wherein:

the first actuating mechanism includes a first angle sensing mechanism for sensing angular movement of the first arm relative to the direction on the surface, wherein the first angle sensing mechanism generates a first angle electrical signal representative of the angular motion of the first arm relative to the direction on the surface; and

the second actuating mechanism includes a second angle sensing mechanism for sensing angular movement of the second arm relative to the first arm, wherein the second angle sensing mechanism generates a second angle electrical signal representative of the angular motion of the first arm relative to the second arm.

28. A method for rendering, comprising:

measuring a first angle related to the position of a first arm and a direction on a surface;

generating an electrical signal related to the first angle;

measuring a second angle related to the position of the first arm and a second arm, wherein the second arm is pivotally connected at a first end to the first arm, and a holder for an implement is coupled to the second end of the second arm; and

generating an electrical signal related to the second angle.

29. The method of claim 28, comprising:

inputting the electrical signals into a computer.

30. The method of claim 28, comprising:

transmitting the electrical signals via channels including those used to transmit telephonic signal.

31. The method of claim 28, wherein:

at least one of measuring the first angle and measuring the second angle includes using a potentiometer.

32. The method of claim 28, wherein:

at least one of measuring the first angle and measuring the second angle includes using an optical angular sensing mechanism.

33. The method of claim 28, wherein:

at least one of the first arm and the second arm has an adjustable length.

34. The method of claim 33, wherein:

the at least one arm having an adjustable length includes a length scale for measuring the length of the arm.

35. The method of claim 33, wherein:

the at least one arm having an adjustable length includes a resource which outputs an electrical signal related to the length of the at least one arm.

36. The method of claim 28, comprising:

measuring an elevation of the holder relative to the surface.

37. The method of claim 36, wherein:

the elevation sensor includes a pressure sensitive switch.

38. The method of claim 28, wherein:

the implement is a writing implement.

39. The method of claim 28, wherein:

a pressure sensitive switch measures a pressure related to the pressure applied by the writing implement to the surface.

40. The method of claim 28, comprising:

reading a code on the writing implement.

41. The method of claim 39, wherein:

the code is related to a color of the writing implement.

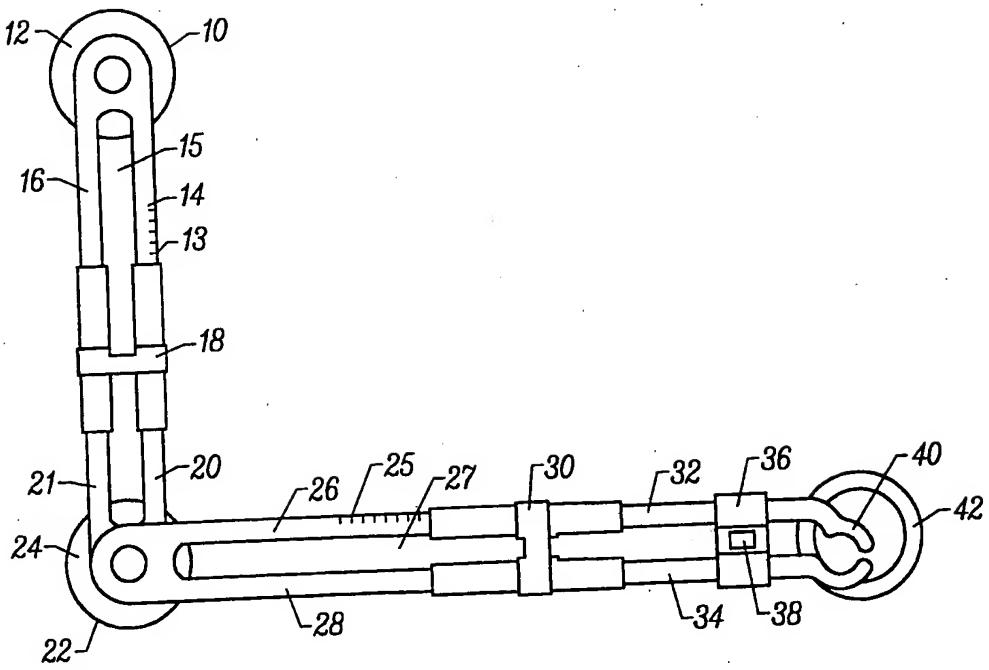

FIG. 1

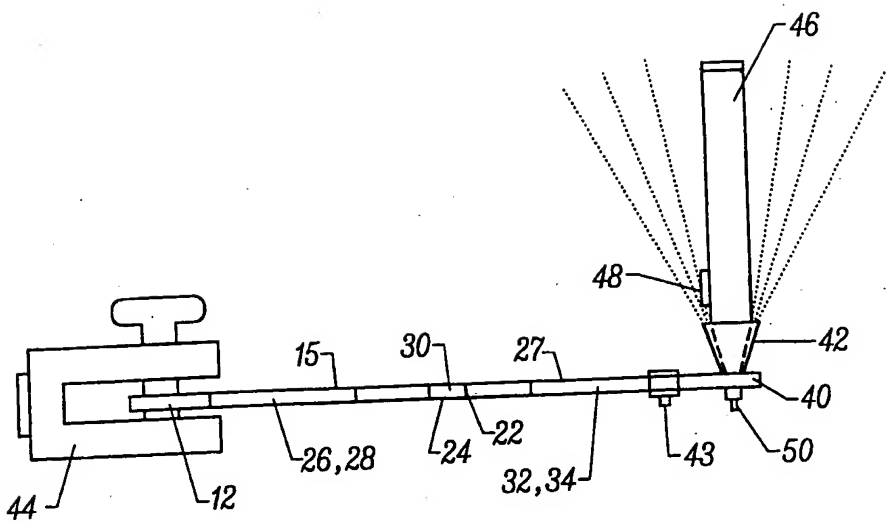

FIG. 2

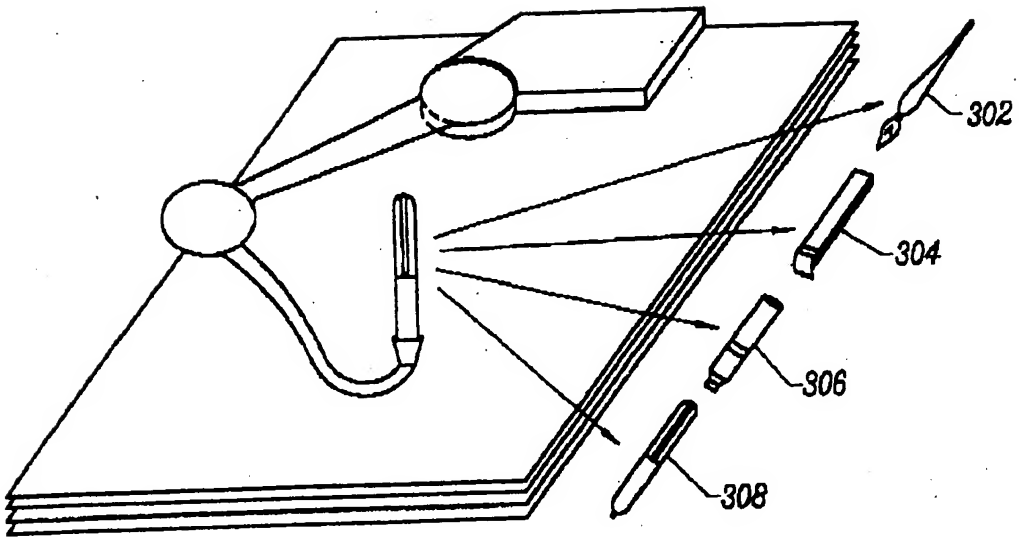

FIG. 3

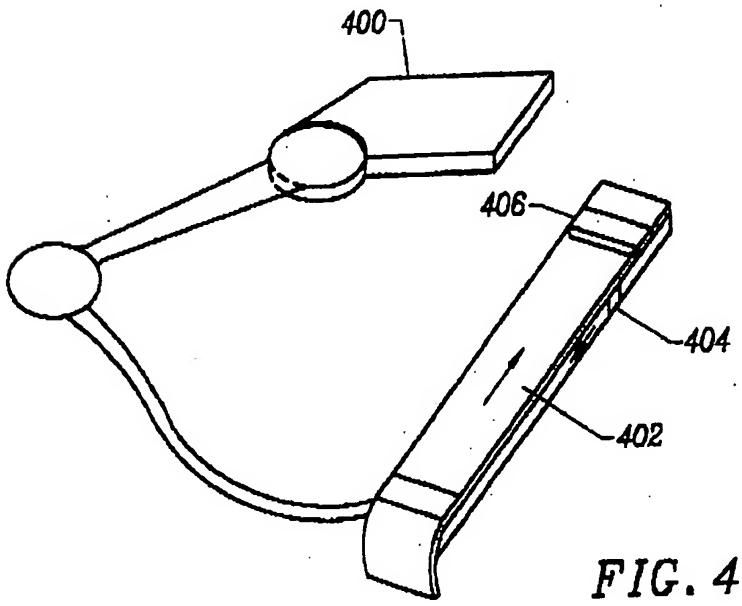

FIG. 4

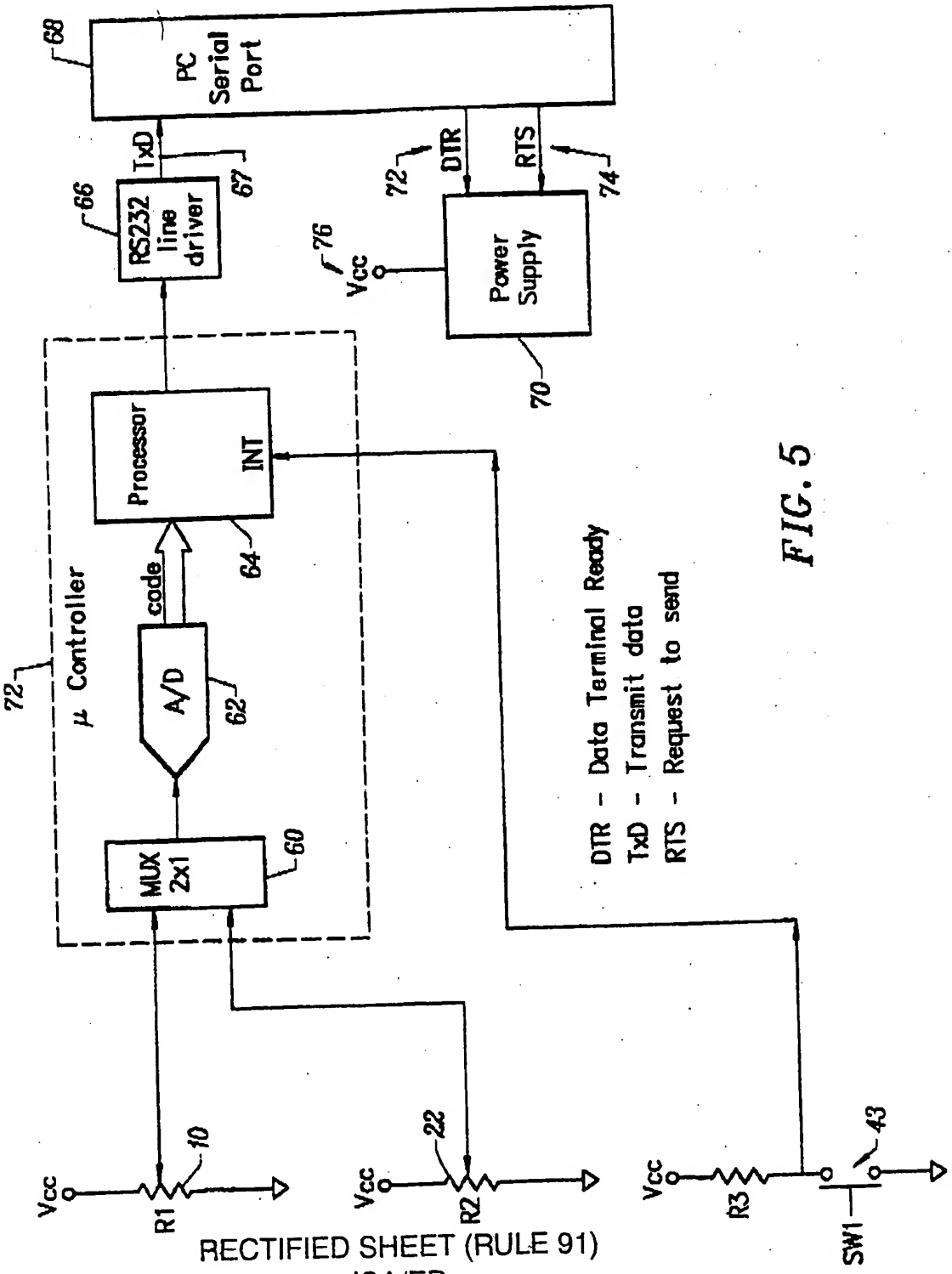
68
PC Serial Port
TxD
67
66
RS232 line driver
72
DTR
RTS
74
76
Vcc
Power Supply
70
Processor
INT
64
code
A/D
62
72
μ Controller
MUX 2x1
60
DTR - Data Terminal Ready
TxD - Transmit data
RTS - Request to send
Vcc
10
R1
Vcc
22
R2
Vcc
R3
43
SW1

FIG. 5

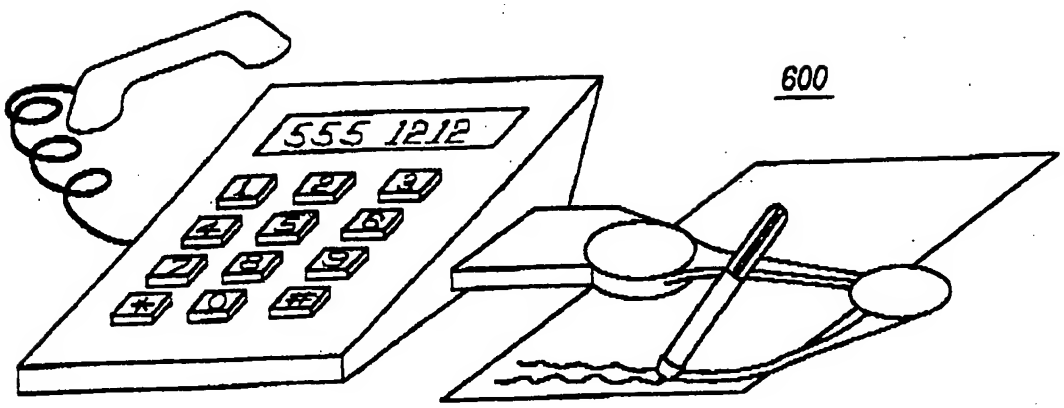
600
555 1212

FIG. 6

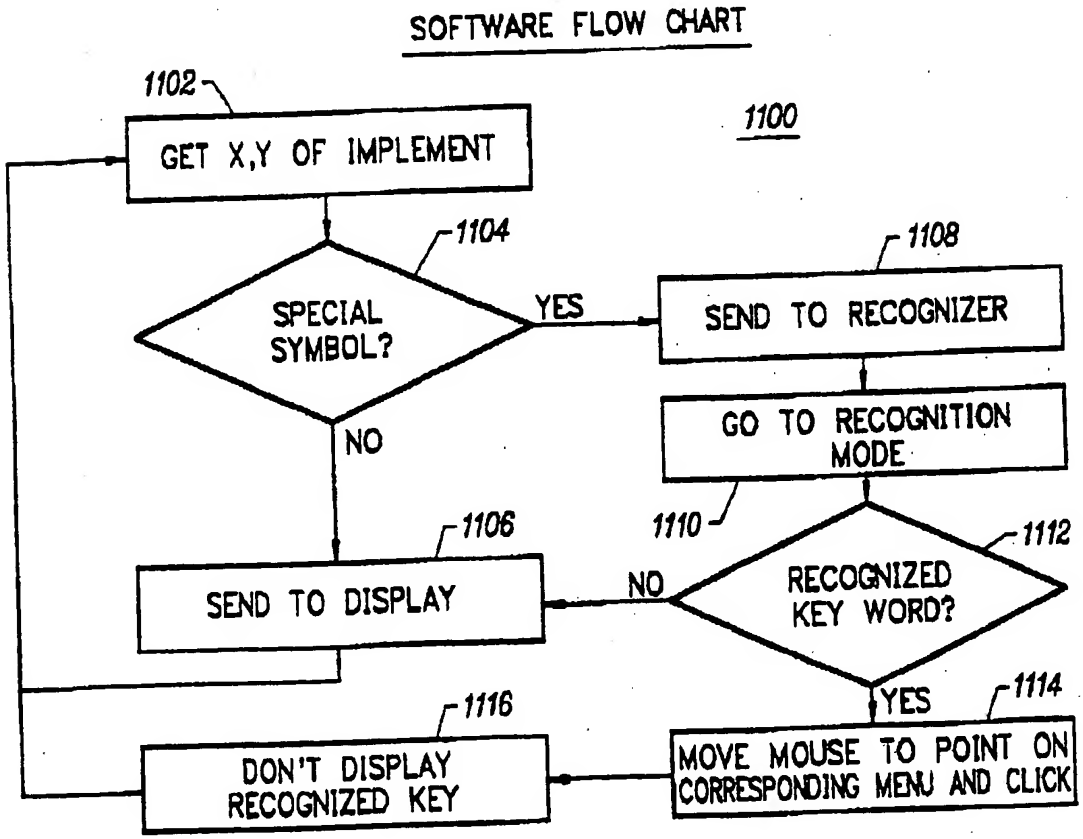
SOFTWARE FLOW CHART
1100
1102
GET X,Y OF IMPLEMENT
1104
SPECIAL SYMBOL?
YES
NO
1108
SEND TO RECOGNIZER
GO TO RECOGNITION MODE
1110
1112
RECOGNIZED KEY WORD?
NO
YES
1106
SEND TO DISPLAY
1114
MOVE MOUSE TO POINT ON CORRESPONDING MENU AND CLICK
1116
DON'T DISPLAY RECOGNIZED KEY

FIG. 11

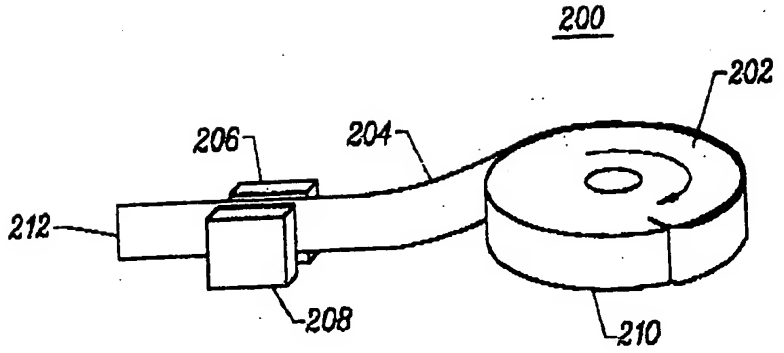

FIG. 10A

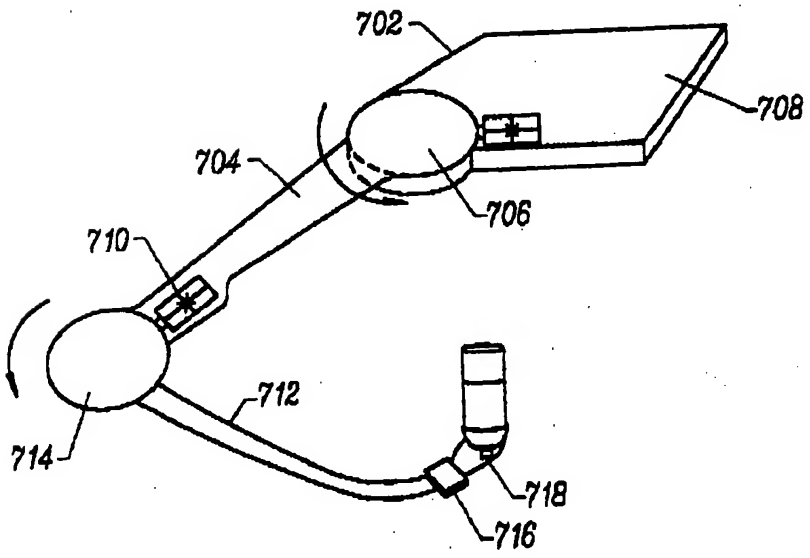

FIG. 7

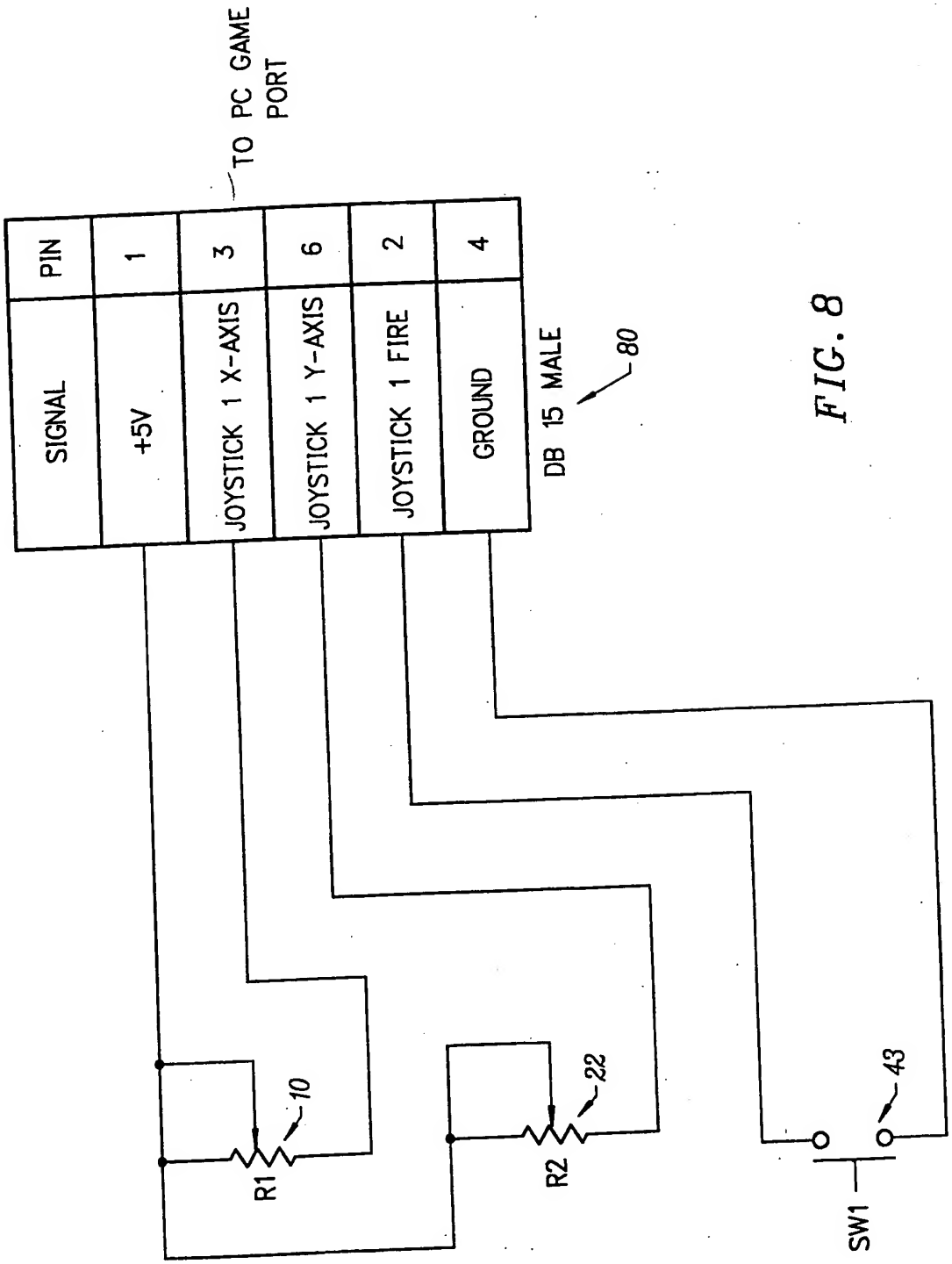
TO PC GAME PORT
PIN
SIGNAL
1
+5V
3
JOYSTICK 1 X-AXIS
6
JOYSTICK 1 Y-AXIS
2
JOYSTICK 1 FIRE
4
GROUND
DB 15 MALE
80
10
R1
22
R2
43
SW1

FIG. 8

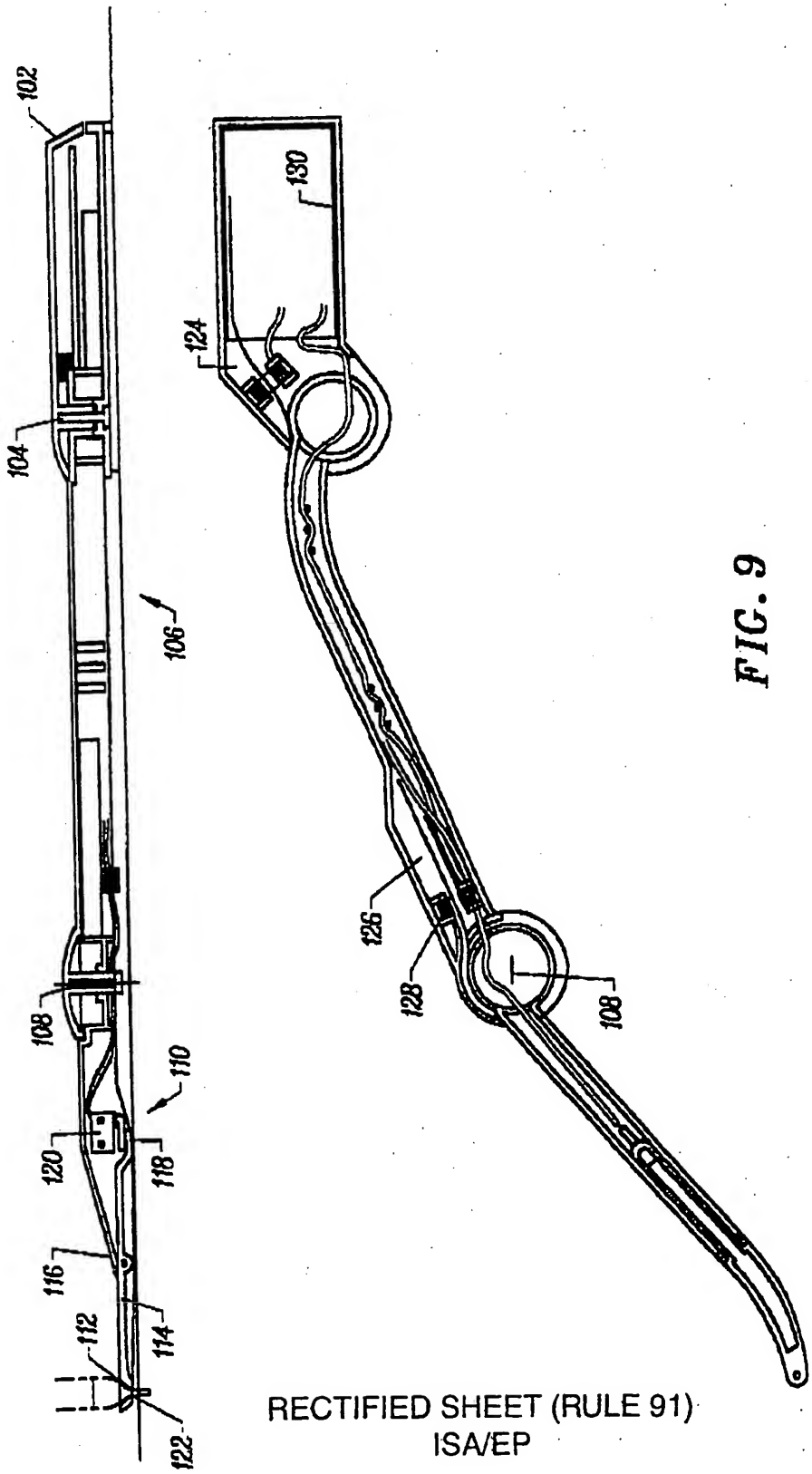

FIG. 9

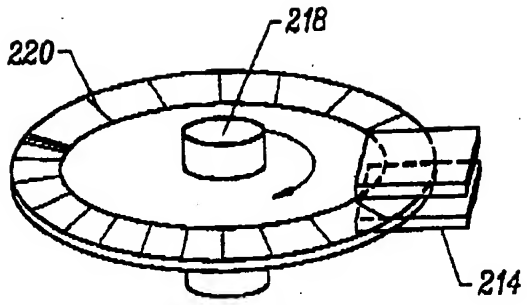

FIG. 10B

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/IB 98/01957

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06K11/18 G06K9/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 500 323 A (FUNK HOWARD L ET AL) 10 March 1970 see column 7, line 49 - column 8, line 59 see figure 4	1,3, 8-11,20, 21,28, 29,32, 38,39
Y		16-19,30
A		2,4,5, 33,40,41

X	US 4 176 455 A (COPELAND THOMAS M ET AL) 4 December 1979 see column 2, line 50 - column 4, line 56 see figures 1,2	22,25-27
A		24
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 April 1999	06/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Baldan, M

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INTERNATIONAL SEARCH REPORT

Int[illegible]ional Application No
PCT/IB 98/01957

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 009, no. 068 (P-344), 28 March 1985 & JP 59 201138 A (ANRITSU DENKI KK), 14 November 1984 see abstract	22,25-27
Y		23
A		24

Y	W. K. FRENCH: "TELE-PROCESSING SYSTEM" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 5, no. 4, September 1962, pages 53-54, XP002100710	1,2, 8-10,20, 21,28, 29,31, 38,39
	see the whole document	4,11-15
A		

Y	US 4 331 954 A (BAUMAN VERNE W ET AL) 25 May 1982 cited in the application	1,2, 8-10,20, 21,28, 29,31, 38,39
	see column 4, line 49 - column 7, line 30 see figures 1-3	
A		3-5,8, 12-16, 27,32, 33,40,41

Y	US 4 071 690 A (JOANNOU CONSTANTINOS JOANNOU) 31 January 1978 see abstract see column 2, line 11 - column 6, line 20 see figures 1,3,4	16-19, 23,30,31

A	PATENT ABSTRACTS OF JAPAN vol. 009, no. 266 (E-352), 23 October 1985 & JP 60 111564 A (TOKYO DENKI KK), 18 June 1985 see abstract	16-19, 23,30

A	EP 0 576 183 A (MATSUSHITA ELECTRIC IND CO LTD) 29 December 1993 see abstract see column 5, line 57 - column 8, line 7 see figure 1	16-19, 23,30

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter[illegible]nal Application No
PCT/IB 98/01957

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3500323 A	10-03-1970	DE 1524439 A	24-09-1970
		FR 1504114 A	09-02-1968
		GB 1152989 A	21-05-1969
US 4176455 A	04-12-1979	NONE	
US 4331954 A	25-05-1982	NONE	
US 4071690 A	31-01-1978	NONE	
EP 0576183 A	29-12-1993	JP 5347674 A	27-12-1993
		US 5469183 A	21-11-1995